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ABSTRACT

This study investigated whether first grade students could be taught metacognitive strategies to solve analogies. Subjects, 34 first grade students randomly assigned to two groups with adjustments made to make the groups equal in gender, ability, and urban or rural geographic location, were pretested for their ability to solve analogies. The experimental group spent 30 minutes per day for 10 days in direct instruction in analogy-solving strategies. An integrated curriculum (webbings) was used throughout the year. Students were taught to verbalize the general rule that "before we learn something new, we must find out what we already know." Various brainstorming techniques were used to accomplish this. The first day of the webbing students were asked, "What do we know about eggs?" or "What do we know about mice?" and responses were recorded on chart paper. These were then categorized according to levels of Bloom's taxonomy and saved to be compared with responses at the end of the webbing. Posttests were administered 2 weeks after the pretest. Results indicated that students in the experimental group were significantly more adept at finding the special relationships involved in the analogy as well as in utilizing a common language to help in its solution. Results also indicated an increased use of metacognitive strategies by students. (Two tables of data are included; journal samples, egg webbing, mice webbing, and 41 references are attached.) (RS)

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First-grade students were given general training in the use of metacognitive strategies as well as specific instruction in solving analogies. It was found that students in the experimental group were significantly ($p < .001$) more adept at finding the special relationships involved in the analogy as well as in utilizing the common language to help in its solution. The increased use of metacognitive strategies by students was also indicated.

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TEACHING METACOGNITIVE STRATEGIES TO FIRST GRADERS

by

LaVonne S. Lee

A thesis submitted to the Department of Curriculum and Instruction and the Graduate School of the University of Wyoming in partial fulfillment of the requirements for the degree of

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TO THE OFFICE OF THE GRADUATE SCHOOL:

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To my mother, Helen Kaelberer, and my children, Daniel, Rebecca, and David, without whose enduring and unselfish support it would not have been possible.

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CHAPTER I

INTRODUCTION

Metacognition seems to be the educational word for the eighties. With the tremendous amount of knowledge available, the problem of overload is surely a realistic one. Rather than trying to develop a curriculum that covers all areas of knowledge, a teacher might be wiser to emphasize metacognitive strategies and problem-solving techniques. Teaching for thinking may be one of the most important tasks facing an educator today. Costa (1981) stresses that if we wish to develop intelligent behavior as a significant outcome of education, instructional strategies purposely intended to develop children's metacognitive abilities must be infused into the teaching methods, staff development, and supervisory processes of our schools. Brown (1980) points out that metacognitive skills do seem to have "ecological validity"--there are recognizable counterparts in "real-world, everyday life" situations. Such skills are needed to follow a recipe, assemble a bike, or whenever one checks results against a criterion of effectiveness. Collins (1987) also makes a

strong case for decontextualizing knowledge so that it can be used in many different settings.

Much empirical research in metacognition has centered around metamemory--that is, knowledge about one's own memory abilities and strategies. Brown (1978) feels that we really "do not need many more studies showing that children do not often think about thinking, remember much about remembering, or have not learned much about learning" (p. 127). What is needed instead is the development of a theory that would enable empirical research to be intelligently directed and to advance forward, rather than sideways, in the attempt to understand the development of thinking. Flavell (1979) agrees with Brown that it will be important to discover the early competencies that serve as building blocks for subsequent acquisitions rather than merely cataloging the young child's metacognitive lacks and inadequacies. Brown also points out that the general problem with previous developmental research is that the forms of metamemory selected for study have resulted in an underestimation of the complexity of operations involved. The concentration has been isolated and fragmentary rather than focusing on the complex interaction of person, task, and strategy variables.

Purpose of the Study

The purpose of this study was to see if first grade students can be taught to solve analogies. This was chosen for the experiment because it is necessary to use metacognitive reasoning and skills, especially self-talk, when attempting to solve analogies. It is a skill which is measurable and for which research data can be collected. First grade students were chosen because so little research has been done with this level. Most metacognitive research has been concerned with children who are considerably older. This procedure will be outlined in the research design in Chapter III.

Since, as previously mentioned, the empirical research has been isolated and fragmentary rather than focusing on the complex interaction of person, task, and strategy variables, this writer has incorporated a two-pronged approach. Several webbings were constructed. A set of instructional objectives encompassing all areas of Bloom's taxonomy as well as many of Gagne's outcomes of learning were comprised. Curiosity, suspense, and novelty were used to foster interest and develop positive attitudes toward learning. Problem-solving skills were emphasized and various techniques were employed in an attempt to improve the metacognitive strategies of the students and to see if

they could then apply these to other areas of the curriculum. The use of webbings was an ongoing procedure.

Operational Definitions

In this paper, a webbing means a thematic unit based on one topic but involving all areas of curriculum.

Cognition refers to the intellectual functioning of the human mind and is characterized by remembering, comprehending, focusing attention, and processing information.

Metacognition refers to the ability to monitor one's own cognition; it is thinking about thinking. It can be viewed as a sequence that begins with the reader's metacognitive knowledge and ends with the use of strategic reading or thinking behavior (Babbs & Moe, 1983). John Flavell (1976), the developmental psychologist who is responsible for much of the current interest in research in this area, further elaborates:

> "Metacognition" refers to one's knowledge concerning one's own cognitive processes and products or anything related to them, e.g., the learning-relevant properties of information or data. For example, I am engaging in metacognition (metamemory, metalearning, metattention, metalanguage, or whatever) if I notice that I am having more trouble learning A than B; if it strikes me that I should double-check C before accepting it as a fact; if it occurs to me that I had better scrutinize each and every alternative in any multiple-choice type task situation before deciding which is the best one; if I sense that I had better make a note of D because I may forget it. . . . Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the

> cognitive objects on which they bear, usually in the service of some concrete goal or objective. (p. 232)

Metacognitive processes include knowledge about cognitive tasks, particular strategies that may be used to solve the task, knowing when and how the strategy should be applied, and the evaluation of the success or failure of any of these processes (Kitchener, 1983).

The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology (1983) states:

> We must return to basics, but the "basics" of the 21st century are not only reading, writing, and arithmetic. They include communication and higher problem-solving skills, and scientific and technological literacy--the thinking tools that allow us to understand the technological world around us. These new basics are needed by all students.

Students need such skills to manage the flood of information in the modern world. The focus must be away from factual knowledge to the teaching of skills essential to accessing, organizing, and using information.

Buccino (1988) reminds us that from now on, for economic reasons, our society must ensure that everybody counts and that everybody is productive. This is in society's best interests, perhaps even its survival. School systems need to identify the thinking skills that ought to be taught, place them in the curriculum, and explicitly teach them. It is only then that all students will have the direct opportunity to acquire those

competencies crucial to being successful in the information age. Teaching for thinking must be included in the curriculum if thinking is to become a durable reality for the future.

CHAPTER II

REVIEW OF RELATED LITERATURE

History and Description of Metacognitive Processes

The history of developmental research concerning metacognition is relatively short. During the 1960's and into the 1970's, there was an upsurge of interest centered around the young child's ability to use active strategies of learning. According to Brown (1975), the majority of these studies concerned rote-learning skills, particularly those of rehearsal and categorization, which were used to improve recall of isolated lists of materials. There have since been many studies showing that the developmentally young were deficient in the use of such skills but could be readily trained to use them.

Brown (1980) specifies three particular problems with studying metacognition in children. (1) The young are less conscious of the workings of their own mind and are thus less able to exert conscious control over their own cognitive activity. (2) It is difficult to externalize mental events and to find out details of their knowledge. It is risky to rely on verbal responses when working with children. Some researchers attempt to overcome this

problem by requiring multiple responses and by insisting on adequate justification for these responses. This, however, increases the risk of Type II errors as children may possess the cognitive skills but be unable to express them adequately. (3) There is often a gap between what children say they know and how they perform. Even when students can identify a superior strategy they often do not use it themselves. Another problem for grade-school children is estimating that certain tasks will be more difficult than others and, therefore, will require more effort or ingenuity. Younger students even have difficulty determining if it will be easier to recall a story verbatim or just to recall the main idea.

The first step in metacognitive processing is knowing when you know. This involves a realization that there is a problem. Markman (1977) assessed the degree of reflective thinking that children engage in about information that they acquire as evidenced by their ability to recognize gaps in that information. First and third graders were given instructions in how to play a game; however, one essential instruction was omitted. They were then asked 10 questions designed to prompt them to think about the instructions they had received, and to determine the point at which they would recognize that the instruction was missing. Only one of the 12 first graders recognized the gap in information before playing the game, while 10 out of

12 third graders did so before playing. Evidently the first graders were unable to evaluate whether they had understood the instructions or not until they actually tried to carry them out.

The second step in metacognitive processing involves knowing what you know. This includes an awareness of the difference between what is known and what is not known. This is sometimes referred to as the problem of "secondary ignorance."

> Part of being a good student is learning to be aware of one's own mind and the degree of one's own understanding. The good student may be one who often says that he does not understand, simply because he keeps a constant check on his understanding. The poor student who does not, so to speak, watch himself trying to understand, does not know most of the time whether he understands or not. Thus the problem is not to get students to ask us what they don't know; the problem is to make them aware of the difference between what they know and what they don't. (Holt, 1964, pp. 28-29)

Many experiments have been conducted concerning the ability of young children to estimate their own memory capabilities. Markman (1973) as well as others found that younger children could not accurately estimate whether or not they could recall a large list of pictures. Brown (1977) did not stop the experiment as soon as a child indicated that a list was too difficult. She instead continued to show the pictures until all 10 were exposed and thus obtained some markedly different results. Some children responded that a list of seven pictures was too

difficult but then proceeded to respond that a list of eight pictures was within their capacity. There is no way of knowing how many "realistic" subjects would have also produced inconsistent results if given the opportunity. For example, 80% of the MA 6 inconsistent subjects in Brown's (1977) study would have been judged realistic if the experiment had stopped when the first "too difficult" response was given. Of the total population this would mean that 28% of the MA 6 subjects would have been judged "realistic." This points out the problem with accepting a child's verbal response as a true estimate of his metamemorial capabilities.

A study by Forrest and Waller (1979) investigated children's skills at evaluating their understanding by using a confidence rating technique. Readers were considered good comprehension monitors if they accurately assessed when their answers were right or wrong. It was found that older children and better readers were more successful at evaluating their performance. Younger readers were less able to evaluate their performance accurately and also had less knowledge about comprehension monitoring and fix-up strategies. One drawback to this technique, however, is that it tests one's ability to judge correctness of an answer given after reading, rather than assessing one's feelings of understanding or misunderstanding during reading.

The third step in metacognitive processing involves knowing what you need to know. A child must learn to know which information he should store for future use. He also needs to keep relevant data updated and be able to retrieve it at a moment's notice. If an unexpected problem arises, he must be able to search for whatever relevant information can be available for retrieval. "The growing child has much to learn about how, where, and when to store information and how, where, and when to retrieve it, as a means to a variety of real life goals" (Flavell, 1976, p. 233).

The utilization of study time requires one to try to determine which material is important and which is less important. Masur, McIntyre, and Flavell (1973) tested first and third grade children, as well as college subjects, to determine how efficient they were in using study time. A multitrial, free-recall task was given. On all trials but the first, the subjects were allowed to select only half of the total number of items for further study. Strategic behavior would indicate selection of items not previously recalled. The experimenters found that both third-grade and college students selected previously missed items for extra study, but first graders appeared to select randomly. Evidently a first grader does not automatically choose missed items for additional study.

The final step in metacognitive processing involves knowing the utility of active intervention. Brown (1978) notes the absence of a direct link between predictions and performance. It was found that MA 6 and MA 8 children all predicted that an active strategy would result in superior recall but only a minority actually used the efficient strategy when told to perform the tasks themselves. By third grade, however, the majority of children did perform the strategy they felt was most efficient. There seems to be impressive evidence of a ceiling of performance at around third grade for the majority of problems set.

In another recent investigation (Ghatala, Levin, Pressley & Lodico, 1983), 126 second-grade children from several elementary schools were given training in using cognitive strategies and monitoring them. The children were given paired-associate lists and taught that although there are many ways to play games, some are better than others and that it is important to use the method that allows one to play better. There was a dramatic positive change in the performance of all children while using the trained strategy (from 39.5% to 98.6%), but only children in the group which received the strategy-utility training resulted in long-term maintenance (83% correct after nine weeks). The students were also able to verbalize why their performance had improved.

Research (Karnes, Johnson, Kohen & Beauchamp, 1986) using metacognitive strategies with preschoolers has shown some promising results. Children were taught to talk to themselves and direct their own activity while they analyzed problems, gathered information, developed a plan, and monitored their own progress. Puppets were used to model the idea of self-talk. Children then practiced verbalizing as they worked through the steps of a problem. Appropriate self-talk was reinforced and evaluating skills were modeled. During the three years of this research project, it was noted that children became more systematic in their approach to a problem, they used plans more frequently, and they did more verbalization about them.

Guidelines for Implementing a Self-Communication Structure

A person who uses metacognitive strategies must become acquainted with himself as a "thinker." In order to do this, Manning (1984) feels that he must understand the importance of self-talk or speech-to-self. She specifies some guidelines that teachers in grades one through twelve might use to help implement a self-communication structure during classes.

First the teacher must be committed to the idea that self-talk will improve performance, including general

problem solving. It is known that many people often revert to talking aloud when attempting to solve problems. Talking aloud helps one to focus attention as well as scan the memory looking for the particular piece of information that is needed. Of course, this self-communication may sometimes be silent, such as when we are reading and say to ourselves, "Wait a minute," or "I don't get it." When listening to a lecture we may regulate our behavior by telling ourselves to listen more closely or jot something down for further reference.

The second guideline involves providing a self-communication classroom environment. If 30 students talk aloud, the noise level may be unacceptable. However, students can be taught to whisper. Manning agrees with Schoenfeld (1985) that modeling by the teacher is necessary.

The third guideline states that teachers must teach students some general concepts of self-communication. The class could first brainstorm some situations in which they talk to themselves and these could be listed on the board. Concrete examples can be chosen and students can role-play self-talk as they try to solve various problems. Once a student is familiar with the concepts involving self-communication, these should be specifically applied to other areas of instruction.

There are four times during instruction when self-communication is very important (Manning, 1984):

a. Self communication <u>While Listening</u> to Directions or Instruction

<u>While Listening</u>

1. Does this make any sense to me?
2. Is there anything missing?
3. What's missing?
4. I need to really listen.
5. I understand this. (I don't understand this.)

b. Self-communication <u>While Planning</u> Work

<u>While Planning</u>

1. Do I have everything I need to do this?
2. Do I know what to do?
3. What should I do first?
4. This is going to be easy (hard).
5. I'll finish this on time.

c. Self-communication <u>While Working</u> on My Assignment

<u>While Working</u>

1. Am I working fast enough? Too fast?
2. Did I skip anything?
3. How am I doing?
4. This is easy (hard) for me.
5. I need to quit daydreaming, or I'll never finish.

d. Self-communication <u>While Checking</u> My Assignment

<u>While Checking</u>

1. Did I complete everything?
2. What do I need to recheck?
3. Am I proud of this work?
4. This looks great! (Horrible)
5. I think I got them all correct. (pp. 48-49)

The last step involves the rote-practice of self-communication skills. Teachers must allow some time during each lesson for students to practice if they are going to

become proficient in the use of these skills. Manning reports that these steps have been field tested by teachers who experienced favorable results and improved mathematics test scores.

Problem-Solving Strategies

According to Dirkes (1985) students must know that they are in charge of three factors: (a) access to the knowledge they have, (b) the context of problems, and (c) their own mental abilities. For example, with flexible access to stored facts, students use more of what they know and make better applications of learned knowledge to problems. A second area of control deals with context and transfer of learning. Problem solvers need to transform what they know to new settings or change the settings so that new knowledge will apply to them. The third strategy is to place students in charge of their mental abilities. Since individual strengths and previous learning differ, students who monitor their thinking use what they know to greater advantage.

Divergent production is another important strategy for developing problem solving. This brainstorming results in an increase in thinking; it reduces impulsivity and increases planning time. Students, however, must be convinced that they can "say what they think" before they

will make observations and hypotheses. Students must feel free to become risk-takers.

Dirkes (1985) lists the following levels of idea production that can be used to solve problems:

1. Begin working on a problem by taking guesses. Choose one.

2. Make fluent idea lists that reflect the character of mathematics, e.g., number, estimates, spatial relations, applications, concepts, examples.

3. List many statements of a given problem in your own words. Select one.

4. Use the four-step creative problem solving process using only given information. Steps: Facts (Item 2), Problem Statement (Item 3), Ideas (Item 2), and Summary or Criteria for a Solution.

5. Use the four-step process introducing probable or possible new facts and assumptions.

6. Increase fluency, flexibility, originality, and elaboration in the four-step process. (p. 12)

Since these strategies are a serious departure from most classroom experience, Dirkes (1985) suggests that experimental research on an intervention program be conducted with careful attention to the length of the instruction and development of enough strategies to overcome current and historical factors that inhibit independent thinking. "For a valid measurement of program effectiveness, therefore, knowledge acquisition, metacognition, and creative problem solving need to be developed concurrently" (p. 22).

The teacher needs to model his own cognitive behaviors and then provide guided practice so that the responsibility for learning is shifted gradually to the student. Teacher involvement then becomes focused on evaluation and encouragement. Instruction is not considered to be complete until independent application of the strategies is ascertained.

Metacognitive Processes and Reading

Guthrie (1982) points out that metacognition is not really a new subject. He compares it to reading flexibility (Rankin, 1979). A reader displays flexibility by making adjustments to meet the demands of the text. The emphasis in the metacognitive studies is on how people take control of their own learning and regulate their attention and efforts to comprehend new ideas and concepts. In other words, metacognitive processes are the operations that allow reading flexibility to occur. Generally, younger and poorer readers do not realize that they must attempt to make sense of what they are reading. They instead tend to focus on reading as a decoding process. Canney and Winograd (1979) presented children with four types of passages involving (1) correct syntax but some semantically inappropriate words; (2) semantic and syntactic violations, but some semblance to connected discourse; (3) strings of random words; and (4) strings of random letters. The

children were asked if each passage could be read and why. The younger students as well as the poorer, older students focused on the decoding aspect, and the poorer comprehenders felt that all except the letter strings could be read. They felt that reading was being able to say words correctly so a passage of unrelated words seemed as readable as an intact passage.

The goal of reading must be to understand the text. One important way to improve comprehension is to self-interrogate. Doctorow, Wittrock, and Marks (1978) performed experiments with 488 sixth-grade children from three West Los Angeles elementary schools. The students (the entire population from these three schools) were given SRA reading placement tests and divided into two reading ability groups. It was shown that reading comprehension improved for both groups when paragraph headings as well as generative-processing instructions were given. However, the paragraph headings added to the generative instructions increased comprehension more for the high-ability readers than the low-ability readers. Generative instructions improved comprehension more for the low-ability readers than the high-ability readers. In summary, the inclusion of headings as well as instructions to pause periodically to question, paraphrase and summarize can increase reading comprehension and recall.

Brown and Smiley (1978) found that when given an extra period for study, children in seventh grade and older improved their recall considerably for important elements of the text. This seemed to be a direct result of their insights into the workings of their own memory and their ability to identify the main ideas. Younger children rarely appeared to be doing anything more than rereading. The older students, however, underlined or took notes during studying.

Bransford, Stein, Shelton, and Owings (1981) found, however, that although poorer students do not spontaneously monitor their understanding and mastery of prose material, they are capable of doing so with relevant instruction. Dansereau and others (1979) similarly found that college students can be taught strategies to reorganize and interpret materials, recall and transfer learned material, and expand knowledge.

According to Babbs and Moe (1983), students should first be taught to develop awareness of themselves as active learners and to consider these steps when reading: (1) think about thinking, (2) know the crucial goal, (3) plan ways to accomplish that goal, (4) check to see whether the goal is met, and (5) take action if the goal has not been met. A successful cognitive skills training program must include skills training, self-regulation training, and awareness training. If only given training

in specific strategies, students often do not know where and when to use them. They must be explicitly instructed in making use of lateral transfer (Baker & Brown, 1984). Although a great deal of interest has been shown in the need for transfer as a criterion of general cognitive improvement, very few experiments have been done in this area. This is mainly due to the formidable time and effort that would be needed to do these. Brown (1978) suggests that the use of the cumulative rehearsal may be a way to make these tasks less time consuming and more feasible. It is suggested that rather than training children for a single task, general skills that can fit a variety of situations should be taught. It seems much more practical to attempt to train children in the use of metacognitive skills which could generalize to a variety of problem-solving situations.

Metacognitive Processes and Writing

A connection between writing and the development of metacognitive processes in reading has been clearly established. Wason (1987), however, developed a study to investigate the contributions that expressive writing could make to first-grade students' learning in mathematics. Once a week, beginning writers were asked to pictorialize and then to write in a mathematics journal reflecting on concepts explored while working in a mathematics center.

Students were asked to respond to this question: "What did I learn or discover this week at the math centers?" Students worked at centers on activities which focused on an inductive, problem-solving model. They then had an opportunity to put mathematical language into their own words and to speculate on solutions in their journals.

> Entries into journals influenced learning by revealing problems, classifying thinking and generating ideas and questions. Students wrote about their puzzlements, frustrations, amazements and interesting facts. Observations became inquiry. Responding to the question "What did you learn," helped students reflect on their own thinking. The process of developing ownership of knowledge was facilitated and enhanced when students wrote in their own terms about the concept being learned. (pp. 5-6)

Another important aspect of Wason's math activities involved making hypotheses or guesses. This encouraged students to take risks and to speculate on answers. Journal writing then became the time for students to reflect on their guesses. Students were told to estimate the circumference of a pumpkin, cut a piece of string that size, and then measure the string around the pumpkin. Entries show that students felt comfortable reflecting on wrong answers.

> Michael, 6:
> The pumpkin was big and then I noticed it shrunk. I cut my string too short because I thought it was the right size. But I was wrong. (p. 14)

Writing in math journals caused students to take new experiences and make them their own.

Metacognitive Processes and Math

The teaching of math has traditionally used an item approach. That is, children are taught to use rote knowledge in answering a multiplication problem such as 8x7=___. In a principle approach, children are taught to imagine seven sets of eight objects each and to deduce the answer to the algorithm. Neither approach allows one to predict when transfer might occur. Lloyd (1981) suggests that it might be possible to overcome these difficulties by using attack strategy training. This involves teaching children a limited set of preskills and a step-by-step system for attacking computation problems of a given class. In an experiment with LD children in a self-contained classroom, it was found that those students who were provided with Strategy Training as well as preskills were able to apply the strategy to problems on which explicit training had not been provided. Transfer was found only if children had been taught both the attack strategy and the preskills. It was not necessary to teach each item in an academic skill area and even LD children could transfer the training to new items when they realized its applicability.

Of particular interest was Siegler's (1984) research which suggests that even preschoolers possess sophisticated strategy choice procedures which help them perform both accurately and efficiently. When children first begin to learn to read, spell, add, subtract, or multiply, they use

a variety of overt strategies, for example, counting on fingers or sounding out words. As students gain experience with the problems, they usually abandon the overt strategies and begin to rely on the internalized solution procedures. Why do students choose one strategy over another? Why do they use overt strategies on some problems and not on others? Is it metacognitive knowledge? "For example, when confronting a complex problem, they might think, 'This is a tough problem, too tough to solve unless I do x, so I'd better do x'" (p. 3). Siegler feels that this may be the case some of the time but not all of the time. He videotaped four- and five-year-olds as they solved simple addition problems to try and determine strategy choices. He found that preschoolers used overt strategies on the hardest problems. He felt this was simply the workings of the cognitive system, rather than metacognitive knowledge, and the children probably made strategy choices based on the strategies they used when first acquiring the skill. This writer disagrees. Since students used overt strategies on the hardest problems, the implication is that their metacognitive knowledge of the difficulty of the problem led to their choices. Siegler bases part of his conclusions on the fact that when asked how hard each problem was, the preschoolers' judgment did not correlate highly with how often they used overt strategies on the problem. However, just because there is

a low correlation between a child's verbalization of his perception of the difficulty of a problem and his choice as a strategy, does not mean that he is not using metacognitive knowledge. For example, it has already been shown that a child's verbal responses cannot be accepted as an indication of what he really knows (Brown, 1980).

The problem of measuring metamemorial judgments is difficult because one is concerned not with what a child is doing but with what he thinks he is doing and why. Because the study of metacognition is still so new, refined measures for assessing metamemorial awareness have yet to be developed. There is a danger in using just one type of response. Some types of responses increases Type I errors, some increase Type II errors, and some are sensitive to response bias effects. Therefore, many different measures of awareness should be obtained, and the single response should be avoided in favor of convergent operations (Brown, 1978).

There is some disagreement as to when children may be developmentally ready to be taught metacognitive skills. Brown (1980), however, feels that metacognitive deficiencies are the problem of the novice regardless of age and that ignorance seems to be the function of inexperience in a new and difficult problem situation. Success in teaching metacognitive strategies to preschoolers has also been demonstrated. This leads

one to believe that children who can think can be taught to monitor that thinking, develop strategies to solve problems, and evaluate the success or failure of their choices.

CHAPTER III

METHODS AND PROCEDURES

Research Hypotheses

Instruction in the general use of metacognitive strategies as well as specific instruction in analogy-solving strategies will increase students' performance on analogy tests. The group that receives instruction in the use of analogy strategies will perform better.

Operational Definitions

An analogy test is a reasoning test requiring a person examined to supply a final term in a proportion. Analogies were specifically chosen because they require metacognitive reasoning and self-talk and they involve a skill which is measurable.

An analogy is an inference that if two or more things agree with one another in one or more respects they will probably agree in yet other respects; a resemblance in some particulars between things otherwise unlike; a mathematical proportion or ratio (as in the statement of the form $a \times b = c \times d$ where the values of a, b, and c are given, so that d may be calculated).

Success in solving analogies is defined as the scale score on a set of analogy tests involving cut and paste pictures as well as verbal responses.

Metacognition refers to the ability to monitor one's own cognition; it is thinking about thinking.

Self-talk is defined as speech-to-self. It is self-communication that takes place while listening to instructions, planning the task, working on the task, and evaluating the results.

Procedures and Research Design

Subjects consisted of two first grade classes--17 students each. The membership in the classes was randomly assigned by the kindergarten teacher at the end of the kindergarten year. However, final lists were matched to make certain that the groups were as equal in ability and gender as possible. Changes were made to help equate the groups. The experimental group consisted of 10 boys and 7 girls; the control group consisted of 11 boys and 6 girls. Approximately one half of the students in each group were from the attendance area of the south section of a small western town with a population of approximately 5,000. The other half were from the rural area assigned by bus routes to the same section.

Pretests were administered to both groups. The tests consisted of two picture analogy tests (1984 Midwest

Publications and 1974 Continental Press, Inc.). These tests involved completing analogies from possible choices. More choices were given than could be used. Students were required to cut and paste pictures to complete the analogies.

The same teacher administered the test to both groups using the exact words when giving directions. No guidance was given once the directions were given. Both pretests were given at 9:00 in the morning on consecutive days. No feedback was given.

During the next 10 days approximately 30 minutes per day was spent teaching direct analogy-solving strategies to the experimental group. These included teacher modeling of strategies and self-talk, verbal analogies, "talking through" possible solutions, finding common language and relationships, and pantomiming. Anecdotal records were kept as students "talked through" strategies. The control group received no instruction, formal or informal, on solving analogies.

The posttest was given two weeks following the pretest. The posttest consisted of two different picture analogy tests and 12 verbal analogy test items. The 12 verbal analogies were randomly selected from a pool of 104 analogy items. The verbal analogy test was given individually to each student in the control group and in the experimental group. This test was administered by a

teacher's aide who spent 2.5 hours per day with each group. Standardized, written instructions were prepared for the aide to use when testing the verbal analogies. Each child's responses were written down exactly as given. In addition, five students from each group were selected randomly and interviewed to determine how they solved the analogies. The original observer attempted to determine the kinds of metacognitive strategies used, for example, how students monitored their thinking, how strategies were chosen, the amount of self-talk, and how the success or failure of choices was evaluated.

An integrated curriculum (webbings) was used throughout the year. Students were taught to verbalize the general rule that "before we learn something new, we must find out what we already know." Various brainstorming techniques were used to accomplish this. The first day of the webbing students were asked, "What do we know about eggs?" or "What do we know about mice?" and responses were recorded on chart paper. These were then categorized according to levels of Bloom's taxonomy and saved to be compared with responses at the end of the webbing.

A tennis ball was rolled across a table followed by an egg. Why did an egg roll in a circle? Why did some eggs float and others sink? What happened inside a fertilized egg when it was placed inside an incubator? These and

other problems were introduced to arouse curiosity about eggs and stimulate learning.

One week before the webbing on mice, a bulletin board announced, MMW Is Coming Soon! (Marvelous Mouse Weeks). Students tried very hard to guess what MMW would be. The first day they were asked, "What do we know about mice?" and responses were recorded on chart paper. Two mice were brought into the classroom. One of the first problems, of course, was naming the mice. To do this students had to learn about democratic decision-making--for example, nominations, voting, and majority rule.

Each day began with a mouse joke--What do cats put in their hot chocolate? Mousemallows! Students soon began inventing their own wonderful mouse jokes. They were again taught to verbalize the general rule that "before we learn something new, we must find out what we already know." Questions and problems were suggested. Some sample problems were: What might happen if each mouse was fed a different diet? (This meant learning what a nutritious diet for a mouse entailed. This was then compared to a nutritious diet for first graders.) Would one mouse have more energy? Would it gain more weight? How could we find out? (Run them through mazes? Weigh them before and after the experiments?) Why do mice have so many enemies? What might happen if this were not so? (Population predictions based on life cycles were made and graphed.) Do most

people like mice? Why or why not? (Interviews of parents and friends were conducted to gather statistical data.) Why was it necessary to wash hands after holding the mice? Is it fair to use mice in experiments to help find cures for diseases? Why do cats and mice hate each other?

Students were taught to stop and think before attempting a problem. They learned to ask specific questions (Do I know what to do? Do I need to know more before I begin? What do I already know that will help me? Is this like any problem I have done before?) The third step involved checking solutions for reasonability and monitoring attempts to see if they were working. The final step was, of course, evaluation. The procedures were based on Costa's (1984) strategies for enhancing metacognition which include:

1. Planning strategy.
2. Generating questions.
3. Choosing consciously.
4. Evaluating with multiple criteria.
5. Taking credit.
6. Outlawing "I can't."
7. Paraphrasing or reflecting back students' ideas.
8. Labeling students' behavior.
9. Clarifying students' terminology.
10. Role playing and simulations.
11. Journal keeping.

This specific procedure was used: Each day students developed a plan of action, set goals, gathered materials, and set time allotments. Questions were generated and prior knowledge assessed. Students were encouraged to verbalize every step of the way and reinforced for appropriate self-talk. For example, one problem was to determine if there was a difference in the length between small, medium, large, and jumbo eggs. It was determined that some tool was needed to measure them. Various units (paper clips, erasers) were used until a standard unit (a centimeter stick) was chosen as the most feasible. Guesses were recorded on a large chart. Students then worked in groups, measured many different eggs, and graphed the results. They were encouraged to "talk through" the problem, and evaluate the procedure as well as the final learnings. This same strategy transferred easily to other problems in the webbing.

A journal was kept to recall experiments, successes and failures, and to evaluate progress.

Metacognitive growth was evaluated by determining if students were becoming aware of their own thinking. Could they now describe what was going on in their own heads when they were thinking? Could they list the steps and tell where they were in the sequence of a problem-solving strategy? Could they identify pathways and dead ends? Could they describe what data were lacking and how they

could remedy this? Were students becoming more perseverant when the solution to a problem was not immediately apparent? Were they becoming more self-correcting and more autonomous in their problem-solving abilities?

Student responses, anecdotal records, journals, and teacher observation were used in evaluating the results.

Null Hypothesis

There will be no difference in the means of the gain scores of the group treated with specific strategy training and the untreated control group, as assessed by a t-test at the 0.05 level of significance (alpha).

Data Collection and Analysis

Pretest Data: The mean scores of the experimental group were compared to the mean scores of the control group.

Posttest Data: The mean scores of the experimental group were compared to the mean scores of the control group.

The differences between the gain scores of the two groups were also compared.

A t-test of gain scores was used to test the statistical significance of the difference in the two scores.

Two months later both groups were retested to check for transfer and retention.

Limitations

The groups may have been too non-equivalent before the study. Each group had a different setting and a different classroom teacher. The researcher tried to teach and model metacognitive skills throughout the year. Both classrooms, however, were using webbings and an integrated whole-language approach. Both teachers strove to create an atmosphere where students felt free to take risks.

The researcher had a different relationship with the students in the experimental group (her own class) than she did with the control group. The experimental group may have been more motivated to perform well or "please" the researcher. For this reason, two experimenters were used. As previously stated, the second experimenter worked 2.5 hours per day with both classes and felt that she knew the students in both classes equally well.

The time between pretest and posttest was short. Perhaps the treatment was not long or intense enough to produce an effect. This was purposely done to rule out the maturation threat as well as to lessen the likelihood of the independent variable being diffused to the control group.

The tests were not standardized. It is very difficult to find standardized tests for first graders in any area, and impossible in the areas of metacognition and critical thinking. Very little research has been done in these areas with children this young. In an attempt to vary task characteristics, three different types of tests were used: cut and paste, verbal responses, and observation and interview.

A true random method for selection was not used. This threatened the population external validity. It is probably true that the results could only be generalized to first-grade students in rural communities in the Rocky Mountains.

CHAPTER IV

RESULTS

Test Results

On the pretest the means of the control group were slightly higher than the means of the experimental group. The control group had a mean score of 5.76. The experimental group had a mean score of 5.35. Maximum possible score was 7.00. None of the subjects had pretraining on solving analogies.

To determine whether specific instruction in analogy-solving strategies would increase the experimental group students' performance on analogy tests, 10 days were spent modeling strategies, "talking through" possible solutions, finding common language and relationships, and pantomiming.

Two weeks later a posttest was administered. The posttest consisted of two different picture analogy tests (maximum possible score was 8.00) and 12 verbal analogy test items. The 12 verbal analogies were randomly selected from a pool of 104 analogy items (Primary Thinking Skills--A 1, Midwest Publications, 1979). Maximum possible score on the posttest was 20. Table 1 shows the posttest means and gain scores for the two groups.

Table 1

Posttest Means and Gain Scores

Group	Pictures	Verbal	Total	Gain Scores Mean	s.d.
Control	4.24	7.65	11.88	6.11	1.84
Experimental	6.82	9.29	16.12	10.76	2.04

A *t*-test of gain scores showed that the results were significant at the .05 level ($t = 9.8$, $df = 32$, $p < .001$).

Using the SPSS statistical package, an analysis of covariance was run using the pretest as the covariate. These results were consistent with the results of the *t*-test which compared average gain scores. For the sake of simplicity only the results of the *t*-test will be reported.

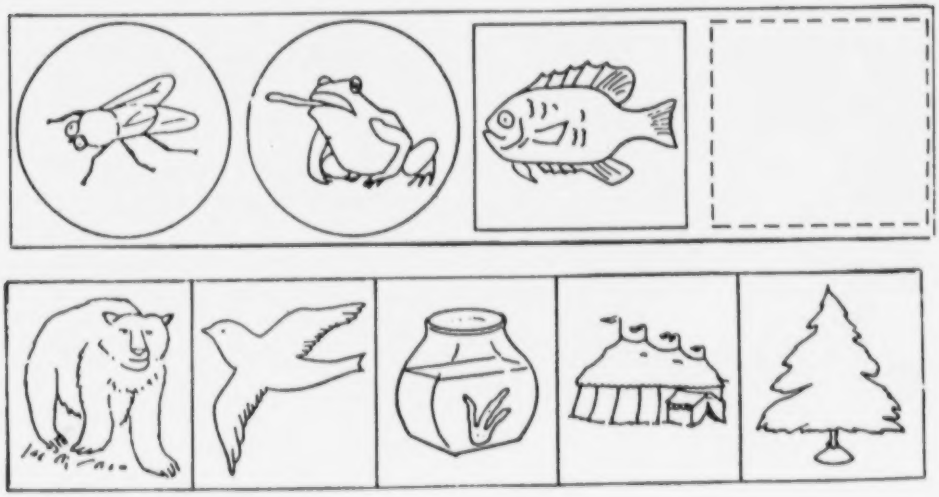
Interview Results

In addition to the cut-and-paste test and the verbal test, five students from each group were randomly selected and interviewed. All interviews were conducted in private areas within the child's school during the regular day.

These directions were given to each student: "Talk out loud as you study these pictures. Tell me everything that is happening in your brain. What are you thinking?

What are you saying to yourself? How are the pictures related?" [Interviewer remarks.]

Test 1



The five responses of the students in the control group are given below:

Student 1: "Frog . . . see, the frog eats the fly--they eat bugs, that's how they're related to me. This (points to fish and tank)." [Why?] "Cause fish swim around in tanks."

Student 2: "The frog catches a fly and a seagull catches a fish."

Student 3: "The fly is flying so the frog can catch it." [What goes with this?] "Water" (in fishbowl). [Why?] "It is what fish need."

Student 4: "All animals . . . bear, bird . . . will fly 'cause they're outside of the water. Fishbowl goes with frog and fish--they're in the water."

Student 5: (Shrug) "The frog eating a bug" (points to fish bowl). [Why?] "The fish goes in it."

The responses of the students in the experimental group are as follows:

Student 1: "The frog eats the fly with his tongue. The bear eats fish but not with his tongue. A bird didn't eat a fish. A fish tank wouldn't eat a fish. A tree wouldn't eat a fish."

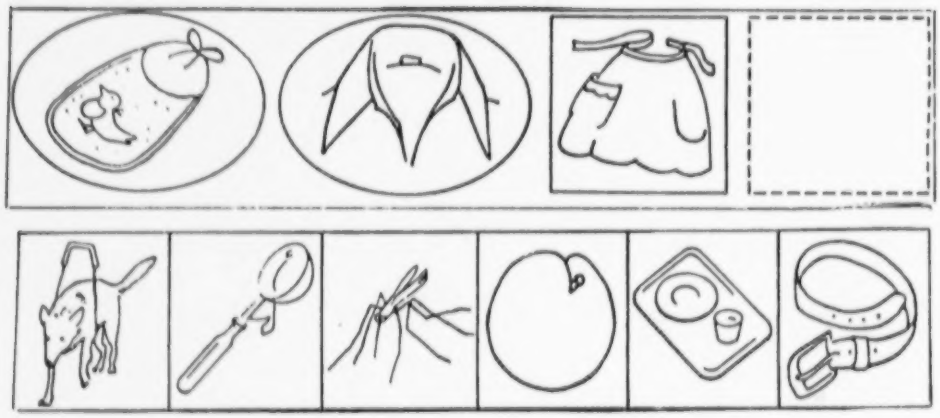
Student 2: "A frog eats a fly and a bear eats a fish."

Student 3: "The frog catches a fly and the fish--no the bear catches a fish. A bird could catch a fish too."

Student 4: "A frog eats a fly, let me see, as a bear eats the fish."

Student 5: (Sits quietly staring at pictures.) [What are you thinking?] "This is to this as that is to that. . . . Frog catches fly and a bear catches a fish. First thought it might go with fish bowl. I thought if the frog was in a pond--but the frog ate the fly."

Test 2



The five responses of the students in the control group are given below:

Student 1: "Bib goes on shirt so you don't get a mess all over. Let's see (points to tray). Tray--because aprons carry trays around and give it to the person who ordered it."

Student 2: "An apron goes to a shirt . . . (sits and stares). [What would the apron go with?] (Points to belt.) [Why?] "It could go around waist so this would stay on."

Student 3: "Bib is related to shirt so food won't get on shirt. Apron to apple--I mean--tray." [Why?] "So they can make things."

Student 4: "Bib . . . I don't know what this is called. Both something that you wear." [What would

the apron go with?] "Belt . . . because you would wear it."

Student 5: "Bib and apron." [Do these two go together?] "No." [What would apron go with?] "Peach, scoop, tray." [Why?] "This is for breakfast, this is for scooping up ice cream, this is for cutting, eating."

The responses of the students in the experimental group are as follows:

Student 1: "That goes on your neck--that goes on your neck. That is like a skirt--it goes on your waist. The belt goes on your waist--none of the rest would work."

Student 2: "You wear them (bib and collar) by your neck. You wear them (apron and belt) at your waist."

Student 3: "A bib goes on a shirt and this goes on? . . . You wear this up there like a necktie and you wear this (apron) like you do a belt."

Student 4: "You tie a bib on a shirt--you tie an apron on a . . . let's see--what I'm thinking of isn't here--what's this?" [Peach.] "It's hard to explain it--a waist or something--I'm trying to figure it out--maybe a belt? [Why?] Well, a belt goes on a waist and a . . . this . . . ties to a waist. This (bib) ties on to a shirt."

Student 5: "That goes on that--this is to this--bib is to collar as apron is to tie--this goes on that--this carries this and this carries this--well, it holds it."

Test 3

Verbal Analogy: PRINCESS IS TO QUEEN AS PRINCE IS TO _____.

The responses of the students in the control group are given below:

Student 1: "Queen." [Why?] "One is a girl and one's a boy and then they get married."

Student 2: "King . . . 'cause if the princess . . . 'cause he's a boy and the king's a boy."

Student 3: "Queen . . . King." [Why?] "'Cause if you married one, he would become the king."

Student 4: "That one I don't know. I don't know what a prince is."

Student 5: "Princess. The queen and the princess and the prince and the princess."

The responses of the students in the experimental group are as follows:

Student 1: "King--'Cause a princess and a queen are the same ones. A prince and a king are royal too. They both live in a palace. Two are girls--two are boys."

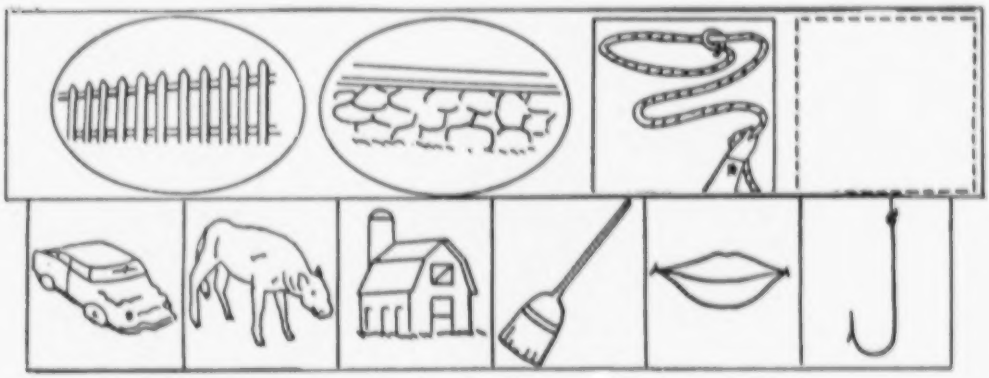
Student 2: "King--I thought I should put it because I thought it was right. It sounded pretty right--both live in a castle."

Student 3: "Well, because the princess is kind of like the queen but the princess has to wait until she grows up and she'll become the queen. How do you decide? The prince will grow up too and become the king."

Student 4: "I forgot the word--a princess to a queen--I forget the word. I'm asking myself what is the name of the thing? You just said prince, didn't you? King!"

Student 5: "Princess is to queen as prince to princess. (Sits quietly.) I don't know."

Test 4



The five responses of the students in the control group are given below:

Student 1: "Both keep things out, keep things in. Rope goes with a cow because they catch on their head and pull them."

Student 2: "I think that someone is throwing a rope. These are fences--a wall and a fence--I would put--I don't know . . . a cow." [Why?] "A cowboy catches cows."

Student 3: "'Cause they're fences--(points to cow). [Why?] "Because it is a rope so they can catch the calf."

Student 4: "Both are gates--what is it?" [Rope.] "Rope would be with hook--hook is hooked on a piece of string and a rope is like a piece of string."

Student 5: "Gate goes with the farm--I wonder what it's called." [Wall.] "Wall goes with barn. That (rope) would go with car." [Why?] "He roped the car 'cause it's all smashed."

The responses of the students in the experimental group are as follows:

Student 1: "That can make stuff stay out--that can make stuff stay out. That can catch something--that can catch something. I thought cow might work 'cause a rope could catch a cow. It would make sense but these both meant the same thing--could catch

something. The others have some of the same possibilities."

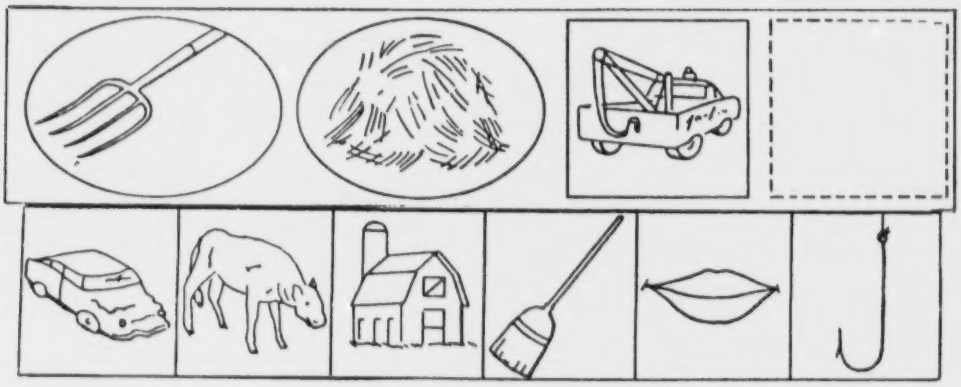
Student 2. "The fence and wall--both do the same jobs--keep things out. The rope and the calf? Keep things still. Does cow do the same job? . . . Must be hook. Can catch things with rope--can catch things with the hook."

Student 3: "Both do the same job because the fence sits there and a wall just sits there. The hoop tries to catch things like the hook." [Did you think of anything else?] "Thought rope would catch the cow but that wouldn't make no sense because the fence and wall does the same job and rope and cow doesn't do the same job."

Student 4: "This is the same type as this--because it holds things in. I know what I'm thinking of--they're both gates. A rope catches things--this is a hook--catches things. First I thought it was cow. Figured out a wall and fence were the same--but cow and rope are not the same kind of thing. A rope catched a cow but not the same kinds of things."

Student 5: "Fence is to? What is that?" [Wall.] "Fence is to wall as rope is to (shrug) . . . hook." [Why?] "'Cause, well, cow--rope catches cow." [Why did you change your mind?] "Because the fence didn't catch the wall."

Test 5



The five responses of the students in the control group are given below:

Student 1: "Stick fork in hay and shovel it--and then they eat them. (Points to car.)" [Why?] "When a car is crashed you have to have it towed away and then they try to fix it."

Student 2: "That scoops hay--the tow truck takes the car to where it can fix it."

Student 3: "Rake scoops up hay so farmers have big rakes to scoop up hay and get it out of there. Tow truck goes with hook. Tow trucks need hooks to get the cars pulled up."

Student 4: "Rake goes with hay--truck goes with truck because a car drives on a road and so does a truck."

Student 5: "The fork goes with hay to the lamb. (Points to cow.) That (tow truck) goes with lips." [Why?] "I don't know."

The responses of the students in the experimental group are as follows:

Student 1: "A pitchfork picks up hay and a tow truck picks up a wrecked car."

Student 2: "A pitchfork picks up hay and a tow truck picks up a car."

Student 3: "The fork picks up hay--truck picks up the wrecked car."

Student 4: "This rakes up hay--this picks up a wrecked car."

Student 5: "That picks up that (hay) and that picks up that (car)."

Table 2 shows a comparison of the number of subjects in the control and experimental groups demonstrating an understanding of the analogy involved, and those using common language to solve the analogy.

Credit was given only if a child showed an understanding of the analogy, rather than merely giving the right answer. Some students will give the correct answer intuitively or merely by guessing. An actual understanding of the strategy is required before transfer can occur. An important metacognitive strategy is not only knowing, but knowing <u>why</u> one knows.

Table 2

Comparison of Control Group and Experimental Group Interview Responses

Test	Control	Experimental
Subjects demonstrating understanding of the analogy involved:		
Test I	1	5
Test II	2	4
Test III	2	4
Test IV	0	5
Test V	1	5
Subjects using common language to solve analogy:		
Test I	1	5
Test II	1	4
Test III	0	2
Test IV	0	5
Test V	0	4

The metacognitive awareness is based on five questions and responses. This small number affects the reliability of the measure. Therefore, the results of this interaction must be interpreted with caution.

To test retention, a cut-and-paste test was administered two months later. The control group had a mean of 5.29 and the experimental group had a mean of 6.56. The maximum possible score was 7.00.

CHAPTER V

CONCLUSIONS, RECOMMENDATIONS, AND SUMMATION

Conclusions

From the results of this study, it can be concluded that first graders can be taught to use metacognitive strategies, especially self-talk, and thus increase their performances on analogy tests. The significant difference as illustrated by the t-test of gain scores indicates that the researcher can feel comfortable in attributing the gains to the treatment and analogy-training intervention.

Students in the experimental group were more adept at finding the special relationships involved in the analogy as well as utilizing the common language to help in its solution. Many more examples of pantomiming were also noted in the experimental group. For example, students were seen touching toe and foot and then touching finger and hand to clarify the relationship in question.

Using the interviews as evidence, few students in the control group seemed able to identify the special relationship of the analogy or to verbalize about it. Again a word of caution: the small size of the group and

the small number of responses affects the reliability of the measure.

The analogy tests can also be used as an aid in recognizing potential. For example, one student scored a 5 on the pretest and a 19 on the posttest. This shows that the potential for learning is there. Her retest score, however, was only a 4. This can probably be accounted for by the fact that her home-life conditions at the time of the retest were very unstable. Her father had recently lost his job and they had just been evicted from their apartment.

The success in solving the analogies may not only result from the specific analogy-solving strategies that were taught but may also be the outgrowth of the various webbings that were used throughout the year. Although webbings, as an instructional model, were used in both classrooms, only the students in the experimental classroom were taught specific strategies to help them monitor their own thinking. In the experimental class, students also seemed to improve their summarizing skills as they evaluated the learnings of the day or in fact if learning had taken place.

Some unedited pages copied from various students' journals during the mice webbing are included in the appendices.

The egg webbing was taught in November of 1988. The mice webbing was taught in April of 1989. When the mice webbing was introduced, nearly every hand was raised in answer to the question, "What is the first thing we need to do before we begin our webbing?" The first student response was, "We must find out what we already know about mice." The second student response was, "We first have to see what we already know so we can learn more."

Costa (1984) enumerates role play and simulations as one of the steps necessary for enhancing metacognition. Students wrote a group story, "I Am An Egg," and individual stories, "I Am A Mouse." Students were able to become a mouse or an egg and record their many adventures.

Students were seen to frequently take time to plan before diving in. Materials were gathered, processes enumerated, and problems anticipated. When making cheesecake, they had planned everything and forgotten the need for a can opener. However, this was discovered before the actual mixing began as several students reviewed the steps and reread the recipe.

Students were seen rereading passages. As one child verbalized, "If I can't remember what is said, I better go back and look."

They seemed to demand clearer directions than before. Rather than diving in, they would ask for clarifications or simply say, "I don't get it."

A music teacher recently remarked that it was easy to tell the students from the experimenter's classroom because they never gave one-word answers but always followed it up with "because" and gave a rationale.

On the last day of school this final activity was used to see if students in the experimental group were continuing to employ the metacognitive strategies concerning evaluation that had been emphasized throughout the year. These directions were given: "Use your metacognitive skills. Evaluate how you are doing. Tell me what you are good at and what still causes you trouble." The unedited results are included below.

Student 1: "I am a good reader. That is because I read lots of books and have good books at home."

Student 2: "I am real good when I read to myself but not so good when I have to read out loud."

Student 3: "I am pretty good but I need to work on expreshun. Most of the time I can figur out words by myself."

Student 4: "I am a real good reader but I have trouble with take away math."

Student 5: "I can read good but need to practus some more. I don't know all the words in Cloverleaf. We are all most done with it."

Student 6: "I am good at reading. I am not good at work. I am real good at writing."

Student 7: "I em doing good."

Student 8: "I can read faster now. Sumtimes I don't no all the wods."

Of course, it is too soon to evaluate any long-term results to see if students will really be able to continue applying the metacognitive strategies when solving future problems. The results do suggest, however, that specific instruction in metacognitive strategies can influence the use of planning time, the amount of self-talk that occurs during learning and "talking-through procedures," and the increased use of evaluative activities.

Recommendations

In the interest of pure research, a first grade group could be tested on metacognitive knowledge and the use of strategies at the end of a year when no such instruction would be given. However, the researcher feels that these strategies are too important to be omitted from the curriculum for an entire year. It would be interesting, however, to follow up on the students in the experimental group to see if they continue to employ metacognitive strategies and become more sophisticated in their implementation.

Summation

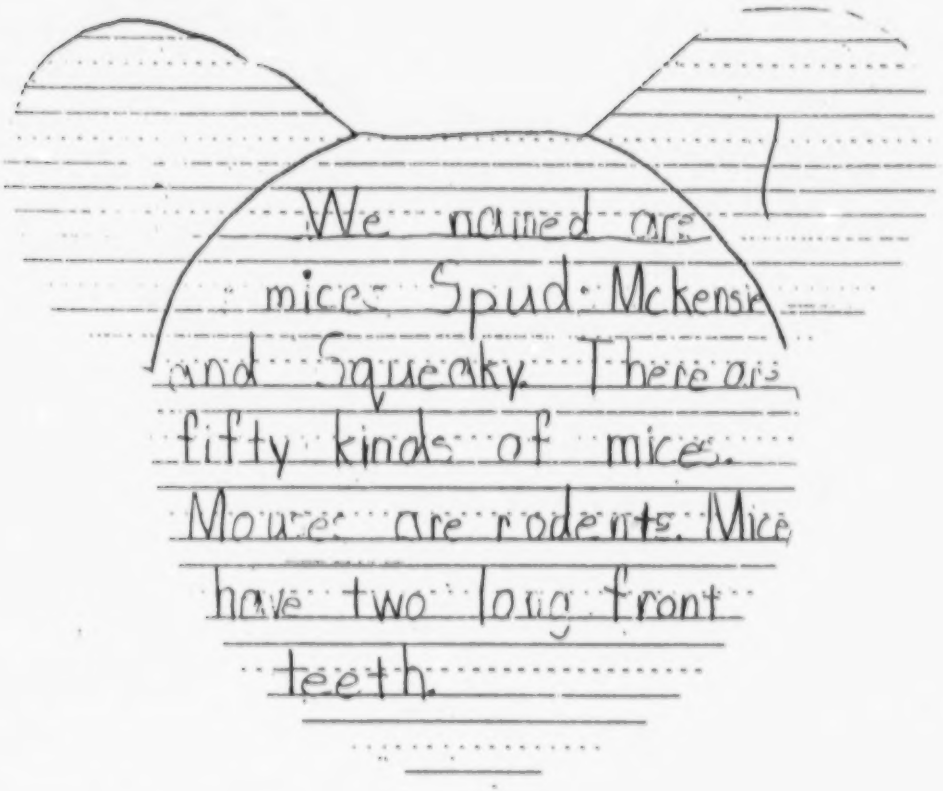
In summation, although little research has been done in the area of teaching metacognitive strategies to small

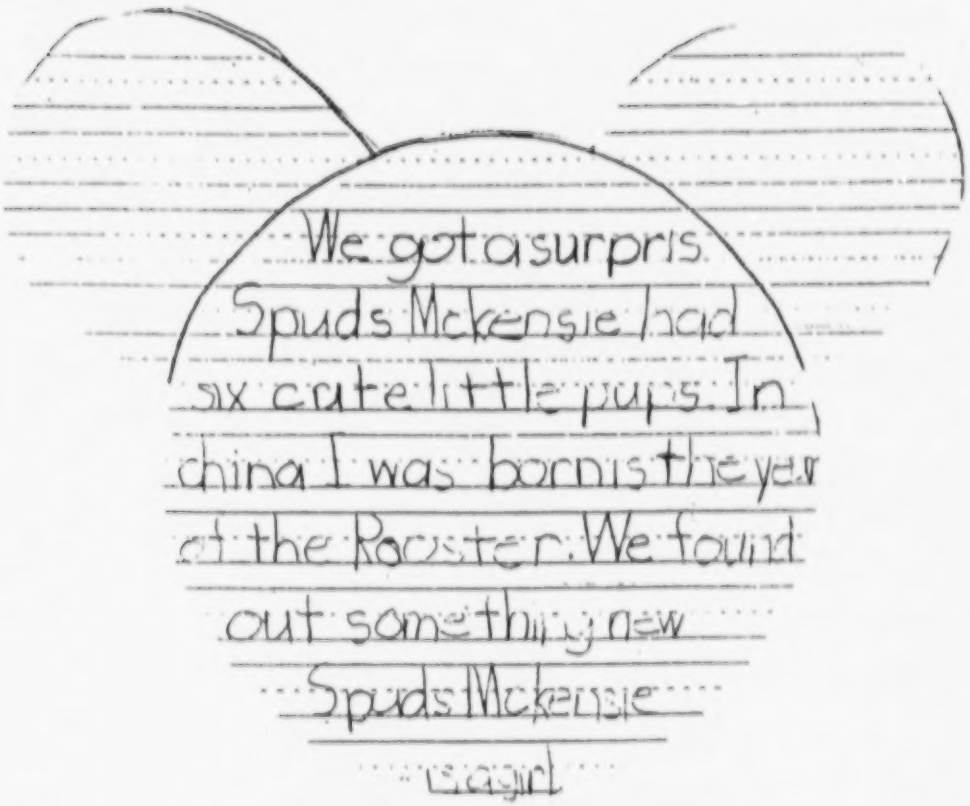
children, indications are that even at an early age, children can be taught to monitor their thinking, develop strategies to solve problems, and evaluate the success or failure of their choices.

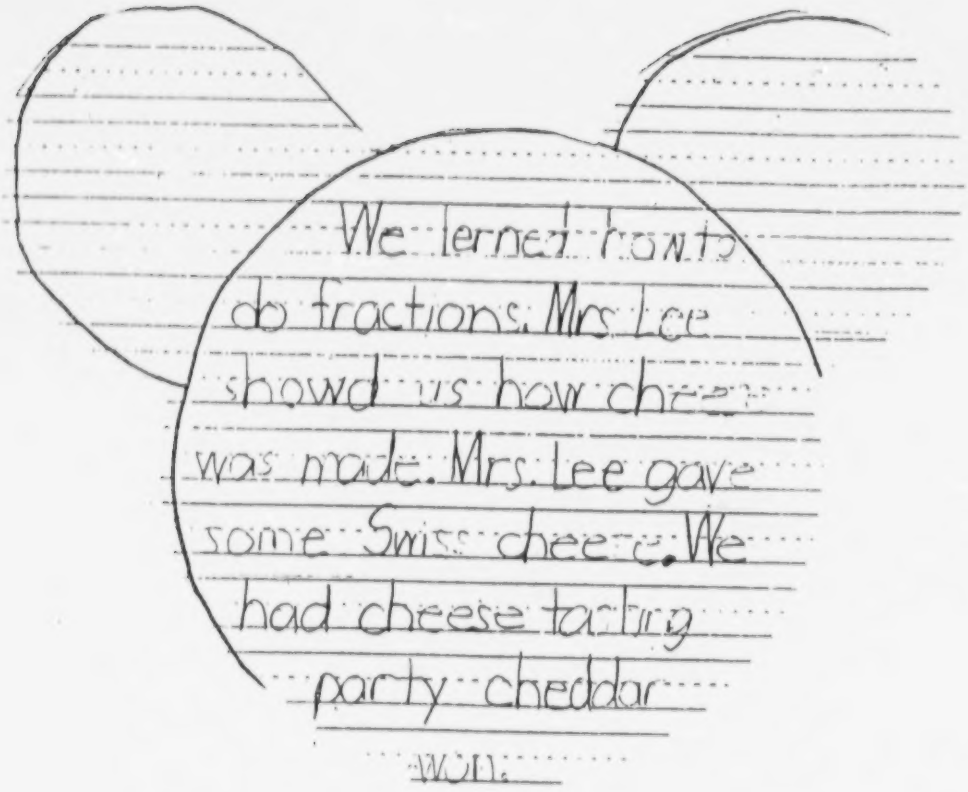
This knowledge could perhaps be of benefit to all elementary classroom teachers as well as anyone else who works with students in any activity or on any project that requires thinking. It would seem that these strategies do provide some groundwork and some guidelines to enable students to make appropriate choices. With the overload of knowledge today, metacognitive strategies and problem-solving techniques will need to have a high priority in any curriculum that attempts to meet the needs of the students of today.

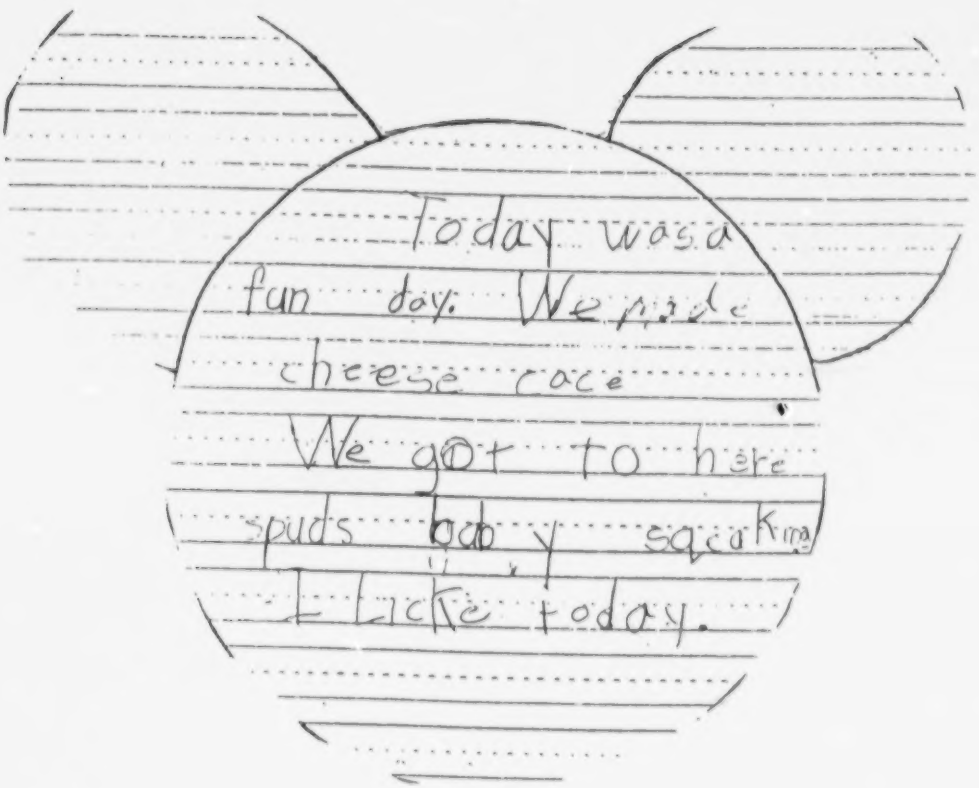
APPENDIX A

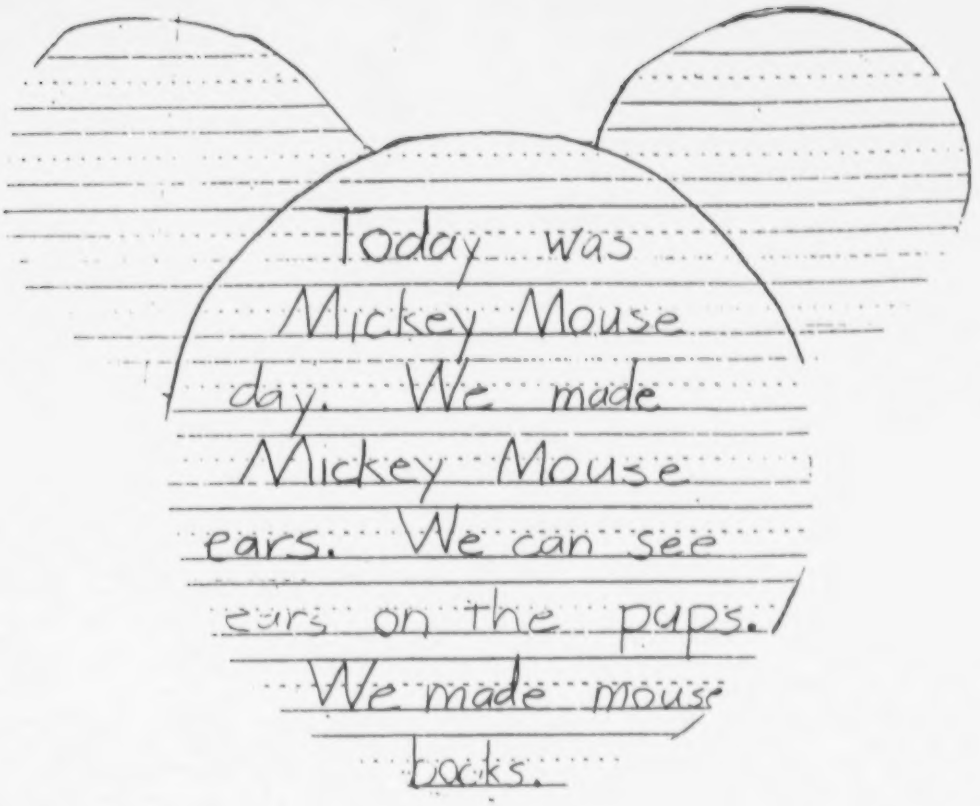
JOURNAL SAMPLES (unedited)

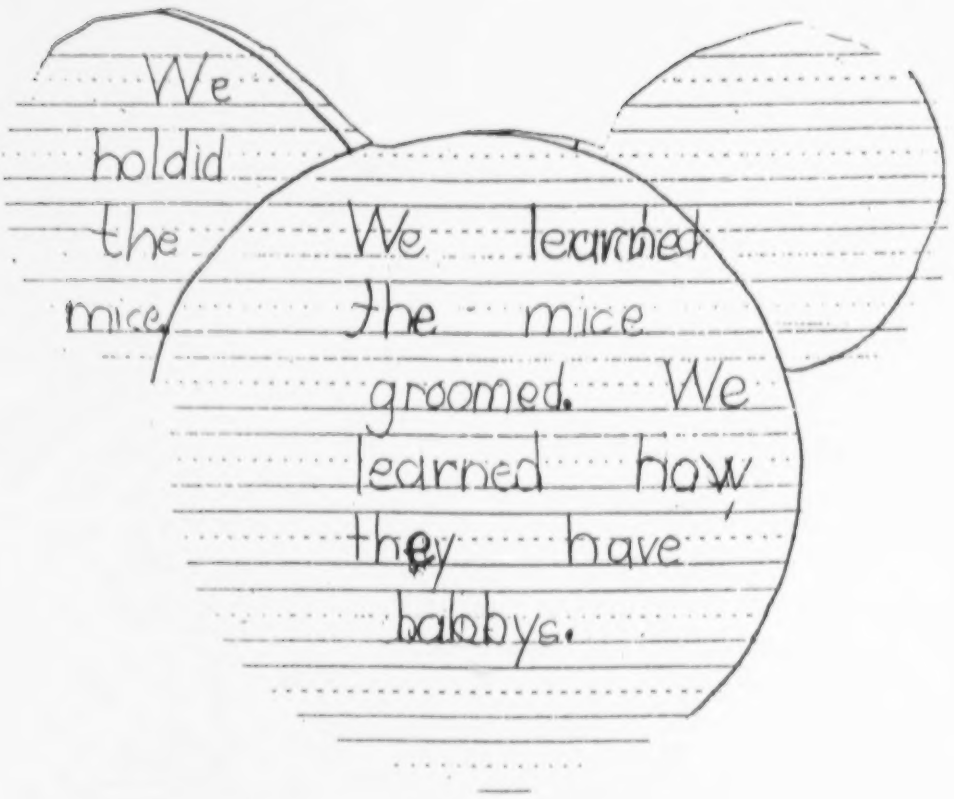


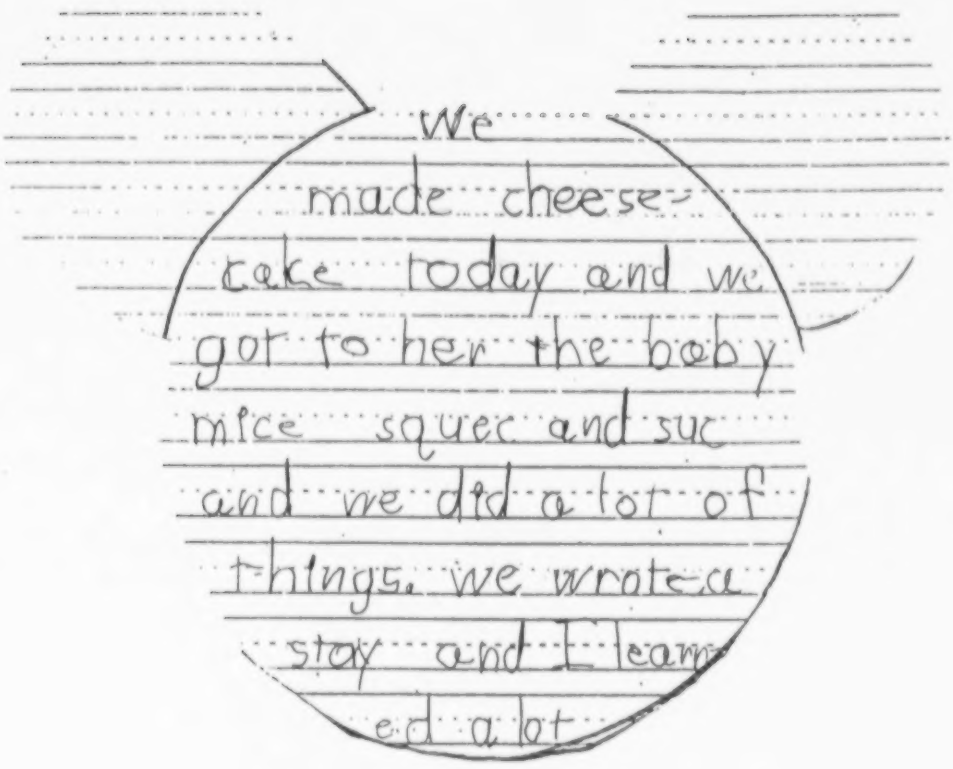

We got a surpris
Spuds Mckensie had
six cute little pups. In
china I was born is the yea
of the Rooster. We found
out something new
Spuds Mckensie
is a girl

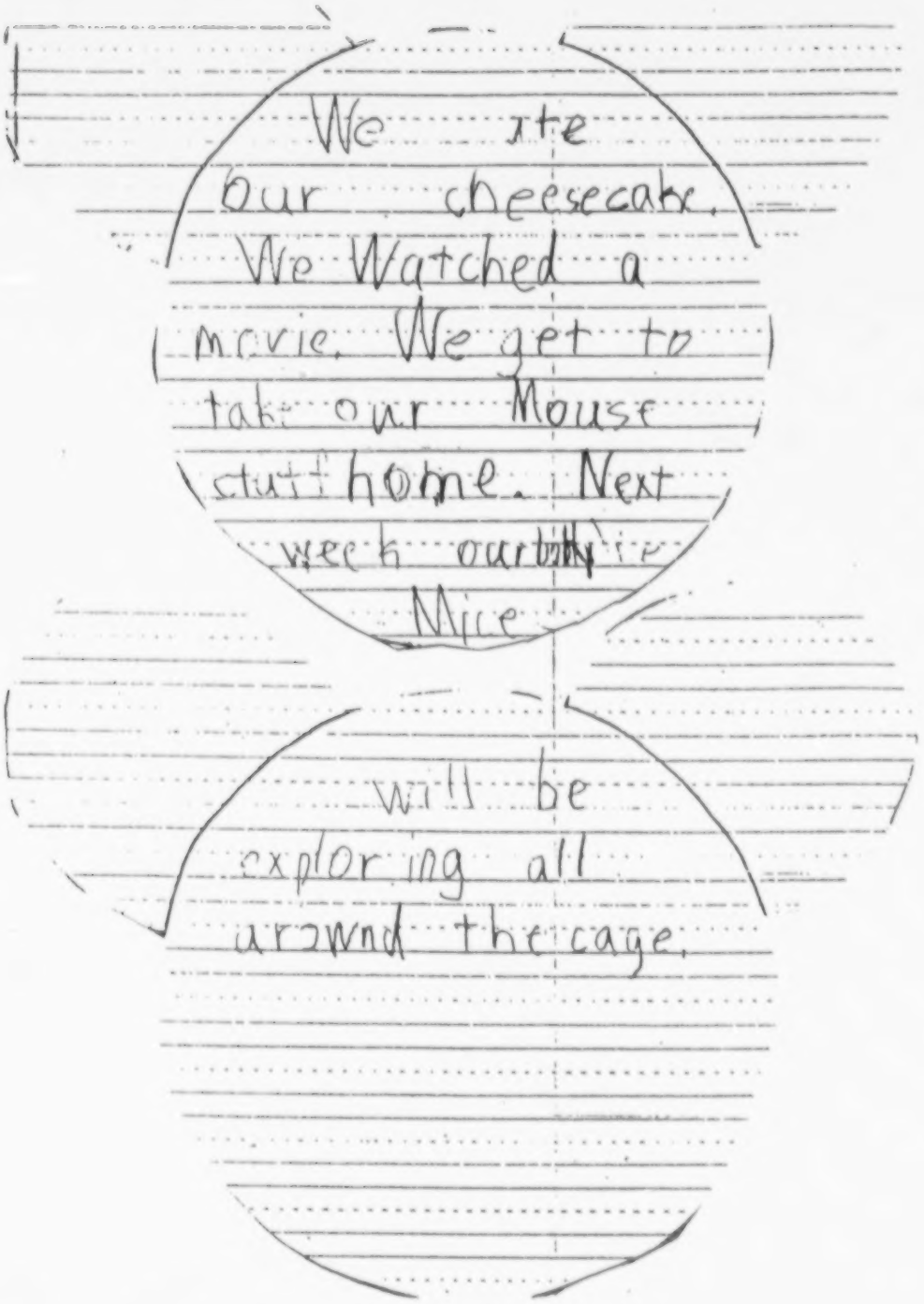

We lerned how to
do fractions. Mrs Lee
showd us how chee-
was made. Mrs. Lee gave
some Swiss cheese. We
had cheese tasting
party cheddar
mon.


Today was a
fun day. We made
cheese race
We got to here
spuds baby squirm
Licke today.


Today was
Mickey Mouse
day. We made
Mickey Mouse
ears. We can see
ears on the pups.
We made mouse
tacks.


We
holdid
the
mice
We learnhed
the mice
groomed. We
learned how
they have
babbys.


We
made cheese
take today and we
got to her the boby
mice squec and suc
and we did a lot of
things. we wrote a
stay and I learn
ed a lot


We ate
our cheesecake.
We Watched a
movie. We get to
take our Mouse
stuff home. Next
week our
Mice
will be
exploring all
around the cage.

APPENDIX B

EGG WEBBING

EGGS
Science and Health
Basic 4 Food Groups
Ways to Cook Eggs (Fry, Boil, Poach)
Nutritious Breakfast (Make scr. eggs with bacon, toast, juice)
Incubate and Hatch Eggs
Life cycle (egg-embryo-chick)
Calcium--egg shells--teeth, bones
Eggs used in baking (Dough)
Reading
Write Experience Story each day. Type on primary typewriter. Use for reading instruction.
Phonics: Short e--egg
Carton game--Classification skills
Egg stories--Read-to stories about eggs (Analyze stories using story maps; make predictions; draw conclusions.)
SSR--simple egg books
L'Eggs--vocab. review
"Chicken Little" pp. 51-63 Once Upon A Time
Math
Compare sizes--measure length in centimeters--graph (small, medium, large, jumbo)
Compare yolks--measure in centimeters--graph
Compare weights--graph
Money problems (1¢,5¢,10¢)
Dozen (12)--Egg Carton Game (put eggs in cartons)
Review # words (1-12)--Egg Carton Game
Addition facts through 10. Use jelly bean eggs for manipulation when solving problems.
Dot-to-dot puzzles; mazes, patterning.
Math worksheets--eggs and chicks.
Oral computation and story problems involving eggs.
P.E.
Movements: Pretend to be animal hatching out of eggs.
Try to make your body into an egg shape.
"Egg rolls."
Egg carton toss.
Social Studies
Field trip to a poultry farm.
Music
"I've Got the Letter E For Egg."

EGGS
Creative Writing
Different viewpoint (pretend to be an egg).
First-person stories-- What adventures will you have?
Journals in the shape of an egg. Write in each day before dismissal.
Literature
"Egg Thoughts"
Poetry
Nursery Rhymes
Humpty Dumpty dramatizations.
Egg "Yokes" (jokes)
Eggs in literature.
Egg Legends (Indian)
Art
Egg bookmarks
Blow eggs and make Christmas ornaments
Humpty Dumpty
Decorate boiled eggs as favorite storybook character
Hatching eggs craft project
Spelling
Egg
Yolk
Hatch
Albumin
Vocabulary
Egg
Yolk
Hatch
Albumin
Incubator
Oval
Germ spot
Omelet
Pores
Candling
Embryo
"Egg" words ("Egg"ceptional, etc.)
Calcium
Egg Nog
Pullets
Grades AA, A, B, C
Research
Candle eggs
Measure eggs' age by floating and breakout test
Filmstrip--"The Good Egg"
Measure shell strength
Test for calcium content (raw egg, vinegar)
Compare weights before and after boiling (pores).
Draw diagram of egg and label.
Egg writing--alum and vinegar.

Bloom's Taxonomy

Gagne's Outcomes of Learning

Knowledge/Verbal Information

1. Demonstrate ability to write the spelling words from memory.
2. Define the vocabulary words.
3. Identify the short e sound in words that are spoken and use this to decode new words containing e.
4. Solve addition problems using number facts through sums of ten.
5. Identify and read the number words one through twelve. Define dozen.
6. Describe the four basic food groups.
7. Observe eggs as they incubate and hatch.
8. Candle eggs and observe development of chicks.
9. Identify the life cycle of an egg from embryo to chick.
10. Illustrate a knowledge of eggs in literature (e.g., "The Golden Egg," Indian legends).
11. Write group experience stories to be used for reading instruction.

Comprehension/Intellectual Skill

1. Discuss the filmstrip "The Good Egg."
2. Solve real-life math problems involving eggs and chicks.
3. Estimate and compare the sizes of eggs and yolks in centimeters.
4. Estimate and compare weights of pullet, small, medium, large, and jumbo eggs.
5. Summarize plot of egg stories and list sequence of events.

Application/Intellectual Skill

1. Make a nutritious breakfast using the basic four food groups.
2. Test egg shells for calcium content--apply conclusions to building strong bones and teeth.
3. Sketch diagram of egg and label.
4. Describe various ways to cook eggs (fry, boil, poach, scramble).
5. Use coins (pennies, nickels, dimes) to simulate situation counting money and determining change.
6. Compare weights of eggs before and after boiling.
7. Blow eggs and make Christmas ornaments.
8. Make egg bookmarks, construct various art projects using eggs and egg-related topics.
9. Take a field trip to a poultry farm.
10. Use problem-solving methods when conducting experiments.

Analysis/Intellectual Skill (Classify, Demonstrate, Generate)

1. Analyze egg stories using story maps.
2. Classify eggs according to grade AA, A, B, C.
3. Classify eggs as pullet, small, medium, large, and jumbo.
4. Deduce the main ideas of stories.
5. Prepare a nutritious breakfast demonstrating knowledge of the four basic food groups.
6. Classify foods according to the four basic food groups.

Synthesis/Cognitive Strategy

1. Pretend to be an egg. Write first person stories. What adventures will you have?
2. Dramatize nursery rhymes.
3. Make predictions and justify when reading egg stories.
4. Decorate boiled eggs as favorite story-book character.
5. Create new "egg" words.
6. Pretend to be an animal hatching out of an egg.
7. Estimate the age of eggs based on the floating test and break-out test.
8. Hypothesize and use scientific method when conducting experiments.

Evaluation/Attitude

1. Evaluate the nutritional value of the breakfast.
2. Draw conclusions when reading egg books. Base conclusions on evidence given and justify.
3. Determine how age affects the nutritional value of eggs.
4. Critically evaluate the webbing using informal surveys, anecdotal records, journals, class participation, and test scores.
5. Assess enjoyment of songs, egg jokes, egg thoughts, and poetry.
6. Keep a daily journal.
7. Develop a positive attitude toward learning.

Psychomotor Skills

1. Make your body into an egg shape--do egg rolls.
2. Play egg carton toss games with jelly beans.
3. Learn to use centimeter ruler and scale to measure length and weight.
4. Measure shell strength. Try to break an egg by squeezing with one hand.
5. Use safe and aseptic techniques when cooking or preparing food.

APPENDIX C

MICE WEBBING

MICE
Science and Health
Observe mice
Predict population
Life cycle
Habitats
Food chain
Nutrition--compare diets--race mice
Disease carriers--hygiene
Scientific research--mice used in experiments--maze timings
P.E.
"Mousetrap Says" (like "Simon Says")
Music
"Mickey Mouse Club"
"Mickey Mouse March"--Record with lummi sticks
Handwriting
Mm (Wind-up Mouse)
Art
Puppets for drama
Chinese flowering trees
Blow art--straws
Decorate journal covers
Murals: Life Cycle of Mice
Mice in literature
Walnut shell mice
Read and draw story
Read and cut story
Mice Bookmarks
Thumbprint pictures
Paper mouse ears
Clay mice
Social Studies
Choose names for the mice
Discuss majority rule
Vote
Chinese Calendar--compare to ours
Year of the Mouse
Find animal for the year we were born
Biographical sketch: Walt Disney
30th Anniversary of Disneyland
Mickey Mouse

Reading
Skills:
- Sequencing
  - List main events from story in order.
  - Follow step-by-step directions when making cheesecake.
- Main Idea
  - Read pages and short stories--summarize meaning in own words
- Theme
  - Try to find the theme in folk tales about mice.
  - "Country Mouse and City Mouse."
  - "Can A Mouse Really Help?"
  - "The Lion and the Mouse"
  - "The Mouse's Wedding"
  - "How Mouse Became Small and Gray"
- Titles
  - Write titles for our stories.
  - Review mechanics of title writing.
- Details
  - Listening Activities--discussion.
- Phonics
  - Long e, i
  - Compound Words--"Mousetrap Game"

SSR--15 minutes per day. Books and stories about mice.

Nursery Rhymes:
- "Hickory Dickory Dock"
- "Three Blind Mice"
- "Little Miss Muffet" (curds and whey)

"Arthur, the Moon Mouse"
"Twelve Years, Twelve Animals"
"Mice" by Rose Fyleman
"Two Scared Mice"

Writing
Shape poems
Poems--similes
Who needs a cheap mouse? What can you do with it? (shoe warmer) (back scratcher) Use it for an earmuff, etc.
Pretend to be a mouse. First person stories--what adventures will you have?
Informational report--Culminating Activity
Write some facts learned about mice. How does factual material differ from fiction?
Stories Main Characters--our mice (3 parts--beginning, middle, end)
Journals in the shape of a mouse. Write in at the end of each day.
Enrichment: Small groups write plays with mice as characters.

Bloom's Taxonomy

Gagne's Outcomes of Learning

Knowledge/Verbal Information

1. Demonstrate ability to write the spelling words from memory.
2. Define the vocabulary words.
3. Identify the long i and long e sounds in words that are spoken and use this to decode new words containing i and e.
4. Solve addition and subtraction problems using number facts through sums of ten.
5. Observe the habits of mice.
6. Observe the development of mice from newly-born through two weeks of age.
7. Identify the life cycle of a mouse and the position of mice in the food chain.
8. Illustrate a knowledge of eggs in literature and nursery rhymes.
9. List various kinds of cheeses.
10. Illustrate proficiency in the use of correct mechanics (capitalization and punctuation) when writing mouse stories.
11. Identify naming words.
12. Learn factual information about mice.

Comprehension/Intellectual Skill

1. Discuss the filmstrips "Mousekin's Golden House," "Mousekin's Family," and "Mousekin Finds a Friend."
2. Discuss the videos "The Lion and the Mouse" and "The Country Mouse and the City Mouse."
3. Discuss the video "The Secret of Nimh."
4. Solve real-life problems involving mice.
5. Summarize the plot of mice stories and list sequence of events.
6. Follow step-by-step directions when making cheesecake.
7. Know the history of cheese and the cheese-making process.
8. Identify compound words.
9. Illustrate correct use of singular and plural forms.
10. Demonstrate understanding of the democratic process and majority rule when choosing the names for mice.

Application/Intellectual Skill

1. Make cheesecake.
2. Compare weights and energy levels of mice fed nutritious diets vs. mice fed a diet of junk food--apply conclusions to nutritious diet for first graders.
3. Use coins (pennies, nickels, dimes) to simulate situations counting money and determining change.
4. Make puppets to be used for original plays.
5. Make mouse bookmarks and construct various art projects using mice and mice-related themes.
6. Use problem-solving methods when conducting experiments.
7. Collect information regarding people's attitudes toward mice--independent research.
8. Illustrate knowledge of fractions by cutting cheese into various sizes.
9. Understand necessity for proper hygiene when handling mice.
10. Using the Chinese calendar, find the animal for year of birth.

Analysis/Intellectual Skill (Classify, Demonstrate, Generate)

1. Analyze mice stories using story maps.
2. Deduce the main ideas of stories.
3. Deduce the themes and morals of fables.
4. Classify foods in the mouse's diet according to the basic four food groups.
5. Graph the results from the cheese-tasting party.
6. Graph the results of the survey regarding people's attitudes toward mice.
7. Compare the Chinese calendar with the Gregorian calendar.

Synthesis/Cognitive Strategy

1. Pretend to be a mouse. Write first person stories. What adventures will you have?
2. Dramatize nursery rhymes.
3. Make predictions and justify when reading mouse stories.
4. Predict the population growth based on the life cycles of mice and graph.
5. Create new "mouse" jokes.
6. Make thumbprints into mouse pictures.
7. Hypothesize and use scientific method when conducting experiments.
8. Imagine the adventures the mice might have if they escape from the cage and write original stories.
9. Create a book similar to an advertisement to convince someone to buy a mouse.
10. Make mouse ears for "Mickey Mouse March."
11. Create shape poems and similes about mice and cheese.
12. Write a puppet play and perform for the group.

Evaluation/Attitude

1. Evaluate the nutritional value of the mouse's diet.
2. Draw conclusions when reading mice books. Base conclusions on evidence given and justify.
3. Examine the ethical issues involved in using mice for research.
4. Critically evaluate the webbing using informal surveys, anecdotal records, journals, class participation, and test scores.
5. Assess enjoyment of songs, mouse jokes, rhythm activities, and poetry.
6. Keep a daily journal.
7. Develop a positive attitude towards learning.

Psychomotor Skills

1. Use lummi sticks for rhythm activities.
2. Play "Mousetrap Says."
3. Learn to use centimeter rule to measure mouse tails.
4. Learn to use cup and teaspoon measurements when making cheesecake.
5. Practice letter formation and spacing--handwriting skills.
6. Use safe and aseptic techniques when cooking or preparing food.

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